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# OSAGE: A NEW BAKING-TYPE POTATO VARIETY RESISTANT TO COMMON SCAB[1]

A. T. Erwin, C. E. Peterson,[3] L. A. Schaal,[4] and W. C. Edmundson[5]

During the past few years there has been an increasing demand for potato varieties resistant to common scab, caused by *Streptomyces scabies* (Thaxt.) Waks. & Henrici). This disease has become a limiting factor in many areas of the country and is a particularly serious problem in some of the productive muck soils of the north-central states. Although resistance to scab has been a primary objective in potato breeding, the important features of yield, market quality, and cooking quality have not been neglected. The need is for a variety equal to Irish Cobbler in yield and cooking quality, but smoother, shallow-eyed and scab-resistant. The new variety Osage is offered as an approach to this goal. It is a long potato, known commercially as a baking-type, or long-white. Tubers of Osage are smooth, shallow-eyed and uniform in type (Figure 1). In most localities Osage shows a high degree of resistance to scab.

## Origin

Osage was tested under the pedigree No. Colorado Seedling 6316. It is a selection from a cross between USDA seedling X 245-186 and Katahdin. The female parent is scab resistant and Katahdin is field immune from mild mosaic and net necrosis.

The pedigree of Osage follows:

- Osage (Colorado Seedling 6316)
  - USDA Seedling X 245-186
    - Richter's Jubel
    - x
    - USDA Seedling No. 444-12
      - Earlaine
      - x
      - USDA Seedling No. 44537
        - Katahdin
        - x
        - Chippewa
  - x
  - Katahdin
    - USDA Seedling No. 24642
      - Sutton's Flourball
      - x
      - Aroostook Wonder
    - x
    - USDA Seedling No. 40568
      - Busola
      - x
      - Rural New Yorker No. 2

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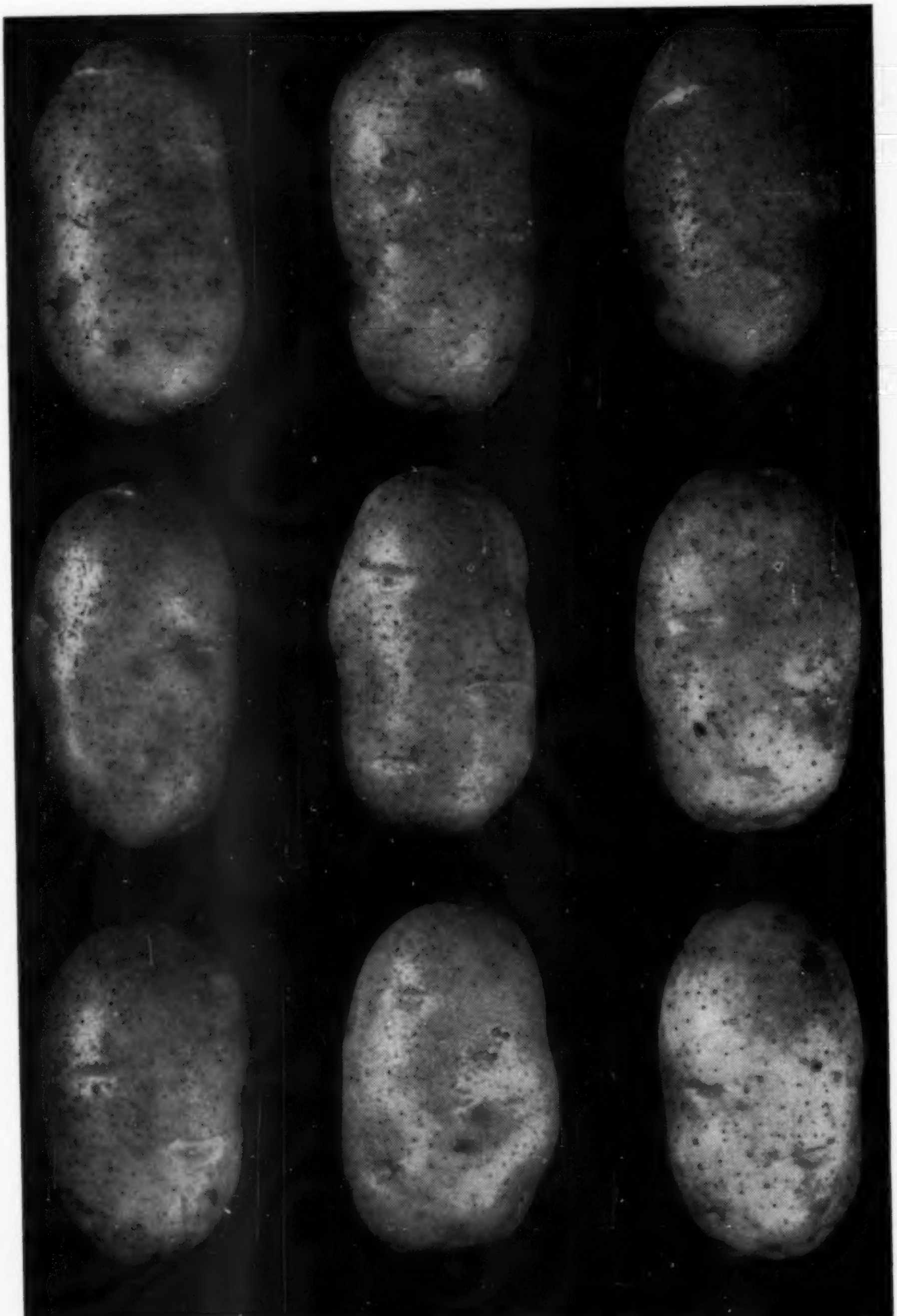

FIGURE 1.—Typical tubers of the Osage variety.

The cross was made and the seedling was grown at the U. S.-Colorado Potato Field Station, Greeley, Colorado. The original single hill was selected at Clear Lake, Iowa in 1942.

## Description

Plants: Medium in size, spreading; stems medium, prominently angled; nodes swollen, mostly green with occasional purplish mottling; wings straight, single; stipules medium to small, clasping; leaves medium, open; primary leaflets, pinnate; under surface and midrib, green and puberulent, cordate; mean length 46.4 ± 0.7 mm (1.8 in.), mean width 33.2 ± 0.5 mm (1.3 in.), index 72.1 ± 1.0.[6]

Flowers: Sepals linear, acuminate, not pigmented, puberulent; pedicel dichotomous and green throughout; corolla medium size, pale lilac with white-tipped lobes; anthers orange yellow; pollen abundant, good; style straight, thick; stigma large, globose, multilobed green.

Tubers: Predominately long cylindrical, somewhat flattened, uniform. Mean length 118.1 ± 1.4 mm (4.6 in.),[7] mean width 65.9 ± 0.5 mm (2.6 in.), mean thickness 52.0 ± 0.4 mm (2.0 in), indexes, width to length 56.3 ± 0.6,[8] thickness to length 44.5 ± 0.5, thickness to width 79.0 ± 0.4.[9] Skin smooth, light tan, considered white in commercial trade. Eyes shallow, of same color as skin; eyebrows not prominent, curved. Flesh white. Maturity medium.

## Characteristics

Osage has been widely tested for yield, quality and resistance to scab. In 1945 as part of the National Potato-Breeding Program Colorado Seedling 6316, together with a number of other Colorado seedlings and seedlings from other states, was tested for scab resistance in Colorado, Indiana, Iowa, Maine, Massachusetts, Michigan, Minnesota, New York, Ohio, South Dakota, Wisconsin, West Virginia, and Wyoming. Since that time it has been tested by State Agricultural Experiment Stations and by growers in Iowa and other states in the north-central section. The results of these tests show that Osage is not immune from scab but has much higher resistance to it than Irish Cobbler or Triumph. Usually the scab lesions found on Osage are superficial and relatively few in number so that a high percentage of its tubers are marketable, even if grown on scab-infested soil. Osage compares favorably with Cherokee in scab resistance but not in resistance to late blight.

Since 1945 Osage has been included six times in replicated yield trials in muck soil at Clear Lake, Iowa. In three of the six years Osage

[6]Calculated by dividing the width of each of 100 leaflets by their length and multiplying the average of these ratios by 100. The leaflets were taken from the fourth leaf from the top of the stem, one leaflet (the distal left lateral) being taken from each leaf. Since the potato leaflet is asymmetrical the length was determined by taking the average of the measurements from the apex to the base of each respective lobe. This is a modification of the method described on pages 163 to 170 of Salaman, R. N., *Potato Varieties*, 378 pp. Cambridge 1926.

[7]Average measurements of 100 tubers each weighing approximately 8 ounces.

[8]Calculated by dividing the width of each of 100 tubers by its length and multiplying the average of these ratios by 100. The data used for calculating the indexes were taken from the same measurements as used to designate the dimensions of the tubers.

[9]Based on the measurements of the same tubers as used for determining the width to length index and with the same methods of calculation.

yielded significantly more U. S. No. 1 potatoes than did Irish Cobbler and in the other 3 years the differences were not significant. The average yields per acre of U. S. No. 1 potatoes over the 6-year period were 394 bushels for Irish Cobbler, 450 bushels for Osage, and 485 bushels for Kennebec (Table 1). In the muck soils where these trials were conducted Osage consistently produced a high percentage of uniform U. S. No. 1 tubers.

In 1946 in the sandy soils of the Gilcrest, Colorado district, Osage produced uniform, smooth, white tubers that were free from scab except for a few superficial lesions. There were very few small tubers and a high percentage of U. S. No. 1 potatoes (Table 2).

Osage was included in tests conducted in Minnesota by O. C. Turnquist. Data on yields from these trials for 3 years (1950-1952) are summarized in table 3. Although the total yields of Osage were generally

TABLE 1.—*Yields per acre, percentage of U. S. No. 1 and total solids of Osage, Irish Cobbler, and Kennebec potatoes at Clear Lake, Iowa, 1946-53.*

| Year Tested | Osage | | | Irish Cobbler | | | Kennebec | | |
|---|---|---|---|---|---|---|---|---|---|
| | Yield per Acre of U.S. No. 1 | | Total[1] Solids | Yield per Acre of U.S. No. 1 | | Total[1] Solids | Yield per Acre of U.S. No. 1 | | Total[1] Solids |
| | Bus. | Per cent | Per cent | Bus. | Per cent | Per cent | Bus. | Per cent | Per cent |
| 1946 | 481 | | | 295 | | | | | |
| 1948 | 449 | 96.6 | 17.9 | 481 | 87.1 | 17.2 | 631 | 97.6 | 17.9 |
| 1949 | 482 | 90.7 | 16.7 | 486 | 79.6 | 16.5 | 544 | 88.7 | 16.9 |
| 1950 | 512 | 94.3 | 18.4 | 415 | 82.8 | 17.4 | 597 | 93.5 | 18.4 |
| 1952 | 597 | 94.0 | 19.4 | 487 | 76.0 | 18.7 | 475 | 71.5 | 18.5 |
| 1953 | 180 | 85.5 | 17.2 | 199 | 53.7 | 18.9 | 179 | 70.5 | 17.7 |
| Mean | 450 | 92.2 | 17.9 | 394 | 75.8 | 17.7 | 485 | 84.4 | 17.9 |

[1]Based on specific gravity of tubers.

TABLE 2.—*Yield of Osage, Triumph, and Yampa in scabby soil at Gilcrest, Colorado. (1946)*

| Variety | Yield per Acre | | Culls Due to Scab | Marketable U.S. No. 1 Tubers |
|---|---|---|---|---|
| | Total | U. S. No. 1 | | |
| | Bus. | Bus. | Per cent | Per cent |
| Osage | 551.7 | 534.2 | 0.0 | 95.4 |
| Triumph | 584.6 | 174.2 | 37.6 | 29.8 |
| Yampa | 642.0 | 613.7 | 0.0 | 95.4 |

TABLE 3.—*Total yields per acre of Osage, Cherokee, Irish Cobbler, and Katahdin potatoes in Minnesota, 1950-1952.*[1]

| Year | Location | Type of Soil | Yield per Acre | | | |
|---|---|---|---|---|---|---|
| | | | Osage | Cherokee | Cobbler | Katahdin |
| | | | Bus. | Bus. | Bus. | Bus. |
| 1950 | Freeborn County | Muck | 903 | 791 | 622 | 863 |
| 1951 | Baker | Red River Valley | 250 | 256 | 250 | 194 |
| 1951 | Fisher | " " " | 230 | 355 | 273 | 142 |
| 1951 | Stephen | " " " | 224 | 355 | 302 | 158 |
| 1951 | Donaldson | " " " | 217 | 361 | 256 | 140 |
| 1951 | Brooklyn Center | Sandland | 266 | 314 | ...... | 241 |
| Mean | | | 249 | 328 | 270 | 175 |
| 1952 | Hollandale | Muck | 445 | 534 | 551 | ...... |
| 1952 | Baker | Red River Valley | 214 | 224 | 248 | ...... |
| 1952 | Fisher | " " " | 263 | 302 | 281 | ...... |
| 1952 | Donaldson | " " " | 258 | 301 | 269 | ...... |
| 1952 | Brooklyn Center | Sandland | 317 | 454 | 394 | ...... |
| Mean | | | 299 | 363 | 349 | ...... |

[1]Data from O. C. Turnquist, University of Minnesota, University Farm, St. Paul, Minn.

lower than those of Cherokee and Irish Cobbler at most locations this variety attracted the attention of growers because of its freedom from culls, long, smooth tubers and relatively early maturity.

The cooking quality of Osage is as good as, if not better, than that of Irish Cobbler. In five years of tests at Clear Lake, Iowa, (Table 1), the average total solids content of Osage was 17.9 per cent and for Irish Cobbler, it was 17.7 per cent. In 4 out of the 5 years Osage had a higher total solids content than did Irish Cobbler.

Osage has produced tubers of high cooking quality in other states. In 1951 and 1952 in the north-central regional trials, Osage produced a higher percentage of dry matter than Irish Cobbler in 8 of the 10 tests reported. At five locations in Minnesota in 1952 (Table 4) the average dry matter percentage of Osage was 19.4 per cent compared with 18.8 per cent for Irish Cobbler; 16.5 per cent for Red Pontiac; 19.2 per cent for Kennebec; and 20.7 per cent for Cherokee.

In Iowa Osage matures a few days to a week later than Irish Cobbler. In most localities in the north-central region where it was tested in 1951 and 1952, it was judged to mature in approximately the same time as Pontiac. In Michigan and northern Minnesota it was reported to mature as late as Katahdin.

TABLE 4.—*Total solids*[1] *of Osage, Cherokee, Irish Cobbler, Red Pontiac, and Kennebec potatoes from several locations in Minnesota, 1952.*[2]

| Location | Osage | Cherokee | Irish Cobbler | Red Pontiac | Kennebec |
|---|---|---|---|---|---|
| | Per cent | Per cent | Per cent | Per cent | Per cent |
| Hollandale | 17.7 | 20.1 | 16.3 | 15.0 | 17.5 |
| Brooklyn Center | 17.7 | 18.7 | 16.7 | 15.0 | 17.3 |
| Baker | 22.5 | 23.5 | 20.3 | 19.2 | 21.2 |
| Fisher | 17.9 | 19.7 | 19.2 | 17.0 | 19.9 |
| Donaldson | 21.2 | 21.3 | 21.3 | 17.7 | 19.9 |
| Mean | 19.4 | 20.7 | 18.8 | 16.5 | 19.2 |

[1]Based on specific gravity of the tubers..
[2]Data from O. C. Turnquist, University of Minnesota, University Farm, St. Paul, Minn.

The storage quality of Osage is good. It is very slow to break dormancy. This is a characteristic of great value to those wishing to store table stock for prolonged periods. However, this characteristic should be kept in mind in handling and storing seed stocks. In experimental plantings in Iowa, Osage was observed to sprout slowly and to emerge more slowly than other varieties unless an effort was made to insure that the seed tubers had broken dormancy and were ready to grow at planting time. To avoid slow emergence and consequent irregular stands a grower should subject Osage seed stocks to a warming period sufficient to break dormancy completely before planting.

The most serious defect observed in Osage is its tendency to develop hollow heart. The development of this defect varies from location to location and from year to year. The Osage variety sets fewer tubers per hill than Irish Cobbler and most other common varieties, and because of this characteristic the tubers have a tendency to become too large. Most hollow heart is found in the large tubers of Osage and experience indicates that close spacing and uniform stands will greatly reduce the incidence of this defect. Because of its low set, closer spacing does not cause a serious increase in the percentage of undersize tubers. Since hollow heart has been observed in varying proportions and in widely scattered locations it seems necessary to caution growers against converting important portions of their production to this variety until they have given it adequate trial. Reports from growers have been conflicting. Some have produced good yields with little or no hollow heart whereas others have found this defect to be serious. Only commercial trial by growers over a period of several years will determine whether this variety can be grown successfully and accepted by the trade.

Experimental data now available together with the experience of growers indicate that the new variety Osage will fill a need for a baking-type potato in some of the scab-infested soils in the north-central region until better varieties can be produced.

# THE RESPONSE OF POTATOES TO IRRIGATION AT DIFFERENT LEVELS OF AVAILABLE MOISTURE[1]

GEORGE A. BRADLEY AND A. J. PRATT[2]

There has been considerable controversy over the proper time to begin irrigation of potatoes and other vegetable crops. How low may the soil moisture be allowed to drop before damage occurs to the crop? One group of workers has found that there was no check in growth as long as any available moisture remained in the rooting zone while others have found decreases in growth as the available moisture dropped toward the wilting point.

Hendrickson and Veihmeyer (6, 7, 8, 9, 10), Adams (1) and Doneen (4) report that plants used up soil moisture without a check in growth as long as any was available in the rooting zone.

Studies by Magness (17), Lewis (16), Furr and Taylor (5), Davis (3), Scofield (19), Wadleigh (21), Cykler (2), Howe and Rhodes (11), Jacob, *et al.* (13) and Taylor (20) have indicated that soil moisture is not equally available over the entire range from field capacity to the wilting point.

The object of the research reported in this paper was to study the effect on the yield and tuber set of potatoes by applying irrigation water when the available moisture dropped to certain levels.

## MATERIALS AND METHODS

Kennebec potatoes were grown on Dunkirk fine sandy loam at East Ithaca, New York during 1952 and 1953 and at Mt. Pleasant (near Ithaca) on Valois stony loam during 1952. The field capacity of the Dunkirk soil was 17.5 per cent and the wilting point was 6.5 per cent. The field capacity of the Valois soil was 24 per cent and the wilting point was 9 per cent.

Plaster of Paris moisture blocks and a Delmhorst Moisture Meter were used to follow the soil moisture during the season. A description of the meter is given in the paper by White-Stevens and Jacob (22), and also by Lecompte (15). Kelley *et al.* (14) found the electrical resistance method of measuring moisture to be satisfactory under field conditions. Comparisons of the soil moisture content as indicated by the blocks with determinations by the oven dry method showed the blocks to be of reasonable accuracy.

During 1952, block readings in the potato row, at a depth of six inches, were used in determining when to irrigate. There were four treatments with three replications at both locations during 1952. The treatments were as follow:

Treatment A — One inch of irrigation water when the available moisture dropped to 50 per cent, as indicated by the moisture meter.

Treatment B — One inch of irrigation water when the available moisture dropped to 25 per cent.

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[1]Accepted for publication January 25, 1954.

[2]Respectively, Graduate Assistant and Professor in Department of Vegetable Crops, Cornell University, Ithaca, N. Y.

Treatment C — One inch of irrigation water when the available moisture dropped to 5 per cent.

Treatment D — No irrigation.

During 1953 the irrigations were based on the average of block readings in the potato row at depths of 6, 12, and 18 inches. The readings at the 12 and 18-inch depths were not considered until they indicated that moisture was being extracted at these depths. The treatments at East Ithaca during 1953 were as follow:

Treatment A — Sufficient irrigation to fill the rooting zone to field capacity when the average available moisture was 50 per cent. The rooting zone was that portion of the upper 18 inches of soil from which the plants were taking water as indicated by the moisture blocks.

Treatment B — Sufficient irrigation to fill the rooting zone to field capacity when the average available moisture was 25 per cent.

Treatment C — Sufficient irrigation to fill the rooting zone to field capacity when the average available moisture was 5 per cent.

Treatment D — No irrigation.

In analyzing the data, the analysis of variance method was used. The treatment variance was broken into three single degrees of freedom; a single degree of freedom for no irrigation *versus* irrigation, a single degree of freedom for the linear component and a single degree of freedom for the quadratic component.

Table 1 shows the total water supplied for monthly periods during 1952 and 1953.

## Results

Figure 1 and table 2 show the effects of irrigation at different levels of available moisture on yield, tuber set and tuber size of potatoes. At East Ithaca during both years there was a significant linear relationship between the yield and per cent available moisture at the time or irrigation. At Mt. Pleasant there were no significant differences in yield.

At East Ithaca during 1952 the linear relationship between total tuber set and available moisture at the time of irrigation was significant at the 5 per cent level.

There were no significant differences in total tuber set in any of the other tests. At East Ithaca in 1952 there was a significant linear relationship between tubers over two inches, and the available moisture at the time of irrigation.

At East Ithaca during 1953 there was a significant linear relationship between the average size of tubers over two inches, and the available moisture at the time of irrigation.

Increased yields of potatoes at East Ithaca during 1952 and 1953 were brought about in two ways. In 1952 the number of tubers ranging above two inches were increased whereas the average size remained the same. In 1953 the number of tubers over two inches was about the same in all treatments, but the average size of the tubers was increased in the plots which were irrigated at the higher levels of available moisture.

TABLE 1.—*Total water supplied (Rainfall and Irrigation)*

| Treat. | June | July | Aug. | Sept. (10 Days) | Total | Ave. Wk. |
|---|---|---|---|---|---|---|
| *East Ithaca, 1952* | | | | | | |
| A | 5.53 | 10.38 | 4.64 | 1.10 | 21.65 | 1.45 |
| B | 4.53 | 9.38 | 4.64 | 1.10 | 19.65 | 1.31 |
| C | 3.53 | 7.38 | 3.64 | 1.10 | 15.65 | 1.05 |
| D | 1.53 | 5.38 | 2.64 | 1.10 | 10.65 | 0.71 |
| *Mt. Pleasant, 1952* | | | | | | |
| A | 3.17 | 9.96 | 5.10 | 1.60 | 19.83 | 1.32 |
| B | 3.17 | 7.96 | 5.10 | 1.60 | 17.83 | 1.19 |
| C | 1.17 | 6.96 | 4.10 | 1.60 | 13.83 | 0.92 |
| D | 1.17 | 4.96 | 3.10 | 1.60 | 10.83 | 0.72 |
| *East Ithaca, 1953* | | | | | | |
| A | 5.04 | 5.55 | 5.38 | ...... | 17.02 | 1.31 |
| B | 4.44 | 6.15 | 4.58 | ...... | 16.22 | 1.25 |
| C | 4.64 | 5.15 | 4.98 | ...... | 15.32 | 1.21 |
| D | 3.04 | 3.15 | 2.98 | ...... | 10.22* | 0.79 |

*After planting on the 20th of May 1953, we had 1.05 inches of rainfall. Soil moisture content was good at all planting dates.

## DISCUSSION AND SUMMARY

Research conducted during 1952 and 1953 has indicated that the potato yields were higher when irrigated before the available moisture dropped much below 50 per cent. This seems especially true on light-textured soils. This was true on light-textured soils whether the rooting zone was filled to field capacity, as in 1953, or whether only one inch of water was applied by irrigation, as in 1952.

During 1952 the major effect of irrigation on potatoes was to increase the number of potatoes over two inches while the average size of the tubers did not vary much. During 1953 the major effect of irrigation was to increase the average size of the tubers above two inches. Pratt *et al.* (18) found that on the whole increased tuber set resulted from irrigation whereas the individual tuber size did not vary much.

All treatments at the same location and during the same season received identical fertilizer treatments. No additional fertilizer was applied after planting. The plots receiving the larger amounts of water indicated a need for more nitrogen late in the season. It is believed that

additional amounts of nitrogen may have resulted in a better response to irrigation. Jacob *et al.* (12) found the need for a higher ratio of nitrogen in the fertilizer with most of the varieties he tested, especially when irrigation was used.

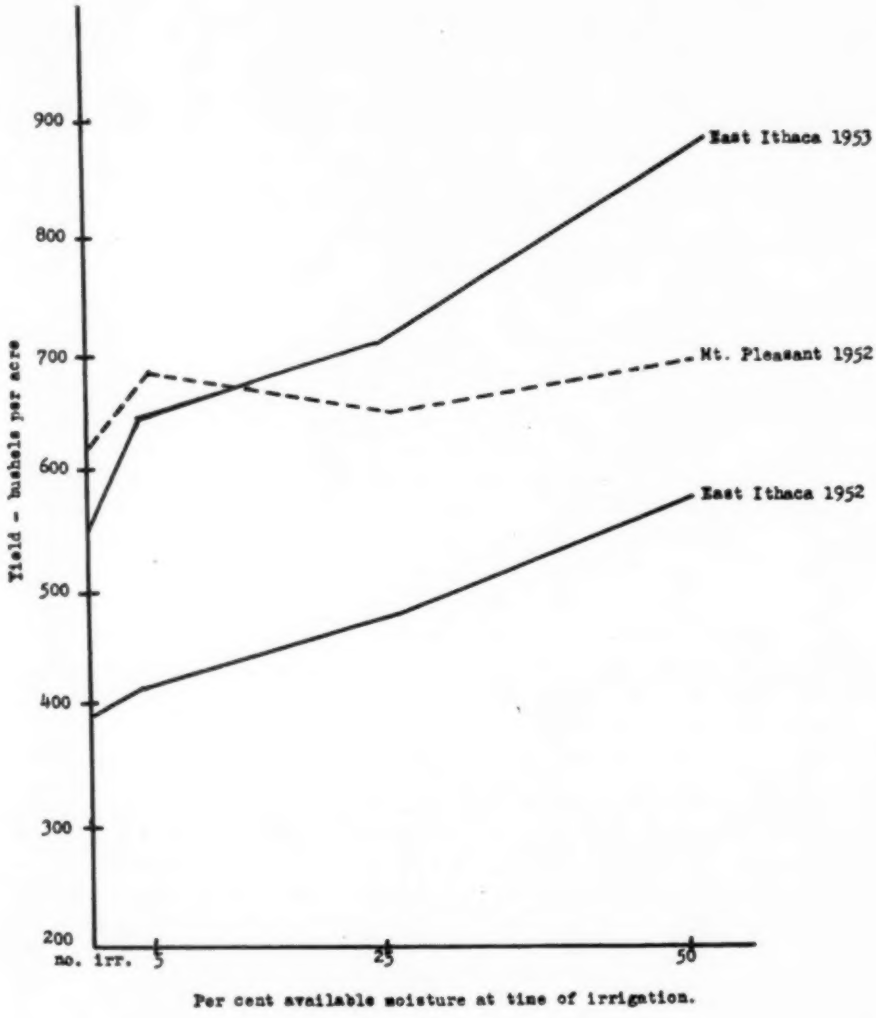


FIGURE 1.—Yield of potatoes as influenced by the moisture level at the time of irrigation.

TABLE 2.—*Effect of time of irrigation on yield, tuber set and size of potatoes.*

*East Ithaca, 1952*

| Treat. | | Total Tuber Set | Tubers over 2" 30 Feet of Row | Ave. Size (Lbs.) of Tubers over 2" | Yield of Tubers over 2" Bus./A |
|---|---|---|---|---|---|
| A | | 289 | 181 | 0.383 | 577 |
| B | | 251 | 145 | 0.396 | 479 |
| C | | 228 | 131 | 0.383 | 419 |
| D | | 216 | 133 | 0.358 | 397 |
| LSD | .05 | 59 | 36 | NS | 83 |
| | .01 | 89 | 51 | | 126 |

*Mt. Pleasant, 1952*

| Treat. | | Total Tuber Set | Tubers over 2" 30 Feet of Row | Ave. Size (Lbs.) of Tubers over 2" | Yield of Tubers over 2" Bus./A |
|---|---|---|---|---|---|
| A | | 246 | 203 | 0.408 | 691 |
| B | | 232 | 198 | 0.395 | 653 |
| C | | 227 | 203 | 0.404 | 684 |
| D | | 205 | 183 | 0.408 | 623 |
| LSD | | NS | NS | NS | NS |

*East Ithaca, 1953*

| Treat. | | Total Tuber Set | Tubers over 2" 30 Feet of Row | Ave. Size (Lbs.) of Tubers over 2" | Yield of Tubers over 2" Bus./A |
|---|---|---|---|---|---|
| A | | 229 | 193 | 0.541 | 871 |
| B | | 237 | 190 | 0.447 | 708 |
| C | | 254 | 194 | 0.396 | 641 |
| D | | 240 | 189 | 0.352 | 555 |
| LSD | .05 | NS | NS | .035 | 59 |
| | .01 | | | .053 | 89 |

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# STUDIES ON THE CONTROL OF POTATO BACTERIAL SEED-PIECE DECAY AND BLACKLEG WITH ANTIBIOTICS[1]

REINER BONDE AND PAULO DE SOUZA[2]

## INTRODUCTION

Studies conducted in Maine (1, 2) have shown that dihydrostreptomycin sulfate and streptomycin sulfate were very effective in reducing the rot caused by the blackleg bacteria, *Erwinia atroseptica*[3]. Streptomycin sulfate gave complete control of the soft-rot decay in potato slices in moist air in Petri dishes following a 30-minute immersion treatment at a concentration of 10 p.p.m. Terramycin hydrochloride, also, reduced the amount of decay on potato slices, but was less effective than the two streptomycins.

Experiments were conducted in 1953 to determine if treating with solutions of streptomycin sulfate and terramycin hydrochloride would control bacterial seed-piece decay and the blackleg disease. The studies were conducted in the greenhouse and in the field.

## CONTROL OF SEED-PIECE DECAY WITH STREPTOMYCIN SULFATE

In one experiment, freshly-cut seed pieces were inoculated with the blackleg bacteria before being treated in the different streptomycin sulfate solutions. In another experiment, similar seed pieces were inoculated after being treated in the antibiotic solutions.

*Treatment of Seed Pieces after Inoculation with Erwinia atroseptica.* Freshly-cut Green Mountain seed pieces were inoculated by being sprayed with a virulent culture of the blackleg bacteria and were immediately placed in streptomycin sulfate solutions varying in concentration from 25 to 200 p.p.m., for periods of time varying from 10 to 60 minutes. The seed pieces were planted in moist soil in pots in the greenhouse and records were obtained on the percentage of decayed seed pieces and healthy plants produced. The data are summarized in table 1.

It can be seen from the data that the streptomycin sulfate treatments were very effective in reducing the amount of seed-piece decay and increasing the stand of healthy potato plants. The 30- and 60-minute treatments were more effective than the 10-minute treatments, except that the latter gave complete control at the 200 p.p.m. concentration. The 30-minute treatment eliminated seed-piece rot in all four concentrations. However, some superficial rot was present when the seed pieces were treated for a 60-minute period at the lowest concentration, namely 25 p.p.m.

Although 80 to 100 per cent of the inoculated seed pieces treated with streptomycin sulfate produced healthy plants, only 10 to 50 per cent of the untreated seed pieces produced healthy plants (Figure 1.). It is thus seen that soaking inoculated seed pieces in solutions of

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This project was financed in part by a research grant from Chas. Pfizer & Co., Inc., Brooklyn, N. Y.
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[3]Bacterial organism causing the blackleg disease. Culture from Lillian C. Cash.

FIGURE 1.—Left, two Green Mountain plants representing those grown from seed pieces inoculated with blackleg bacteria and then soaked in streptomycin sulfate solution. Right, plants representing those grown from seed pieces similarly inoculated but not treated with the antibiotic.

streptomycin sulfate protected them from bacterial rot so that, when planted in soil, they produced a good stand of healthy plants.

There was progressively less decay, and more healthy plants resulted from the longer treatment with water which probably resulted from the dilution of the inoculum (Table 1). When seed pieces were inoculated and not soaked, all of them decayed.

*Treatment of Seed Pieces before Inoculation with Erwinia atroseptica.* The second experiment was conducted to determine if treatment of cut seed in streptomycin sulfate solutions would protect them from soft-rot due to subsequent inoculation. Freshly-cut seed pieces were soaked for 20-, 30-, and 60-minute periods in four concentrations of streptomycin sulfate and were inoculated with a virulent culture of the blackleg organism and planted immediately in moist soil in greenhouse pots. Table 2 summarizes the data obtained from this experiment.

It can be seen that soaking seed in streptomycin sulfate at concentrations of 25, 50, and 100 p.p.m. for 10-, 30-, and 60-minute periods completely prevented seed-piece decay. Also, all of the treated seed pieces produced healthy plants. In contrast, a high percentage of seed-piece decay and dwarfed plants occurred where the seed pieces were treated with water only. The reason that some decay occurred in seed pieces treated with the 200 p.p.m. streptomycin sulfate solution is not known. It is possible that this higher concentration injured the seed pieces.

TABLE 1.—*Effect of streptomycin sulfate treatments on seed piece decay when seed was previously inoculated with Erwinia atroseptica.*

| Concentration P.p.m. | Length of Treatment and Effect | | |
|---|---|---|---|
| | 10 Minutes | 30 Minutes | 60 Minutes |
| 0 (Water Control) | 80- 10[1] | 70- 40[1] | 50- 50[1] |
| 25 | 20- 80 | 0-100 | 0-100 |
| 50 | 10-100 | 0-100 | 0-100 |
| 100 | 10- 90 | 0-100 | 0-100 |
| 200 | 0-100 | 0-100 | 0-100 |

[1]The first figure is the percentage of seed pieces decayed; second figure shows percentage of seed pieces producing healthy plants.

TABLE 2.—*Effect of streptomycin sulfate treatments on seed piece decay when seed was subsequently inoculated with Erwinia atroseptica.*

| Concentration P.p.m. | Length of Treatment and Effect | | |
|---|---|---|---|
| | 10 Minutes | 30 Minutes | 60 Minutes |
| 0 (Water Control) | 80- 20-80[1] | 60- 0-50[1] | 50- 0-50[1] |
| 25 | 0-100- 0 | 0-100- 0 | 0-100- 0 |
| 50 | 0-100- 0 | 0-100- 0 | 0-100- 0 |
| 100 | 0-100- 0 | 0-100- 0 | 0-100- 0 |
| 200 | 20- 90- 0 | 0- 95- 0 | 0-100- 0 |

[1]First figure gives the percentage of seed pieces decayed; second figure, the percentage of seed pieces producing healthy plants; third figure the percentage of seed pieces producing dwarfed plants.

## Comparison of Streptomycin Sulfate and Terramycin Hydrochloride for Control of Seed-Piece Decay and Blackleg

Studies conducted in Maine have shown that a common soil organism *Pseudomonas fluorescens* may cause a seed-piece decay and rotting of potato tubers. The question arose as to whether antibiotics can be used to control the rot caused by this organism as well as the rot caused by blackleg bacteria.

Freshly-cut potato seed pieces were inoculated with *P. fluorescens, E. atroseptica,* and a mixture of these organisms. The inoculated seed pieces were dipped for a 30-minute period in solutions containing four different concentrations of streptomycin sulfate, terramycin hydrochloride, and a mixture of these two antibiotics. The inoculated and treated seed pieces and the untreated controls were planted in pots in the greenhouse and observations made on the amount of seed-piece decay and blackleg that resulted. The results of this experiment have been summarized in table 3.

The data show that the four concentrations of streptomycin sulfate practically eliminated the seed-piece decay caused by both of the organisms when used alone for making the inoculations. Some shallow superficial decay, however, was present when the seed pieces were inoculated with

both of the organisms in combination before being treated with streptomycin. This decay, however, was not very active and did not prevent the formation of healthy potato plants.

It also can be seen from the data in table 3 that soaking the inoculated seed pieces in solution of terramycin hydrochloride did not control the decay caused by the blackleg organism, although it caused a slight reduction in the rot caused by *P. fluorescens.* (See Figure 2). The solutions containing both streptomycin sulfate and terramycin hydrochloride eliminated seed-piece decay caused by *P. fluorescens* and by the mixture of this organism and the blackleg organism. There was, however, some decay when the seed pieces were inoculated only with the blackleg organism and treated in the solutions containing both antibiotics.

The control of blackleg is closely associated with the control of seed-piece decay caused by *E. atroseptica.* Although the percentage of blackleg plants was low in these experiments it can be noted that none appeared in the plants grown from seed pieces that had been treated with streptomycin sulfate. In contrast, from two to five per cent blackleg occurred in the plants from the control seed lots that had been inoculated with blackleg bacteria and soaked in water. Treating the inoculated seed pieces with terramycin hydrochloride did not eliminate blackleg.

TABLE 3.—*Control of two kinds of bacterial decay and blackleg by treatments with streptomycin sulfate and terramycin hydrochloride.*

| | Concentration as P.p.m. | Percentage Seed-piece Decay and Blackleg[1] | | | | | |
|---|---|---|---|---|---|---|---|
| | | *P. fluorescens*[2] | | *E. atroseptica* | | *P. fluorescens* and *E. atroseptica* | |
| | | Rot | Blackleg[3] | Rot | Blackleg[3] | Rot | Blackleg[3] |
| Streptomycin sulfate | 25 | 10 | 0 | 0 | 0 | 15 | 0 |
| | 50 | 0 | 0 | 0 | 0 | 15 | 0 |
| | 100 | 0 | 0 | 0 | 0 | 10 | 0 |
| | 200 | 0 | 0 | 0 | 0 | 5 | 0 |
| Water control | —— | 20 | 0 | 90 | 3 | 75 | 4 |
| Terramycin hydrochloride | 25 | 10 | 0 | 90 | 4 | 90 | 4 |
| | 50 | 20 | 0 | 100 | 3 | 100 | 4 |
| | 100 | 0 | 0 | 100 | 2 | 100 | 2 |
| | 200 | 5 | 0 | 100 | 1 | 100 | 2 |
| Water control | —— | 30 | 0 | 98 | 2 | 90 | 2 |
| Streptomycin sulfate and terramycin hydrochloride (mixed equal parts) | 25 | 0 | 0 | 30 | 0 | 0 | 0 |
| | 50 | 0 | 0 | 10 | 0 | 0 | 0 |
| | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 200 | 0 | 0 | 0 | 0 | 0 | 0 |
| Water control | —— | 25 | 0 | 95 | 2 | 92 | 5 |

[1]Average of 100 inoculated seed pieces for each treatment.
The seed pieces were inoculated by being sprayed with virulent cultures and allowed to dry for 15 minutes before being treated in the antibiotic solutions for 30 minutes.
[2]A common soil organism isolated by Donald Folsom from potatoes, cultures identified by B. A. Friedman. This organism may cause a slow decay in potato seed pieces.
[3]Indicates plant infection.

FIGURE 2.—Green Mountain plants grown from seed pieces inoculated with blackleg bacteria and then soaked in antibiotic solutions. Right, after soaking in streptomycin sulfate solution. Left, after soaking in terramycin hydrochloride solution. The difference is due to the much greater effectiveness of streptomycin sulfate in preventing seed-piece rot.

These data indicate that treating contaminated seed pieces in streptomycin sulfate solutions may eliminate blackleg, besides eliminating to a large extent the losses from seed-piece decay and missing hills. Such control was obtained with all the different streptomycin sulfate concentrations although the lower concentrations were somewhat less effective than the higher in some instances.

## FIELD TRIAL

It may be asked whether the results of the experiments conducted in the greenhouse can be applied to treating seed potatoes under field conditions. The inoculation of seed pieces with virulent cultures of the pathogen were much more severe than normally would have occurred in practice.

In another experiment conducted in 1953, 100 blackleg-inoculated Kennebec seed pieces were treated in a streptomycin sulfate solution (50 p.p.m. for 30 minutes) and planted in the field. All of these seed pieces produced healthy plants. In contrast, inoculated, untreated seed pieces were nearly completely destroyed by bacterial decay and produced practically no normal plants. Although no blackleg infected plants resulted from the inoculation, the experiment demonstrated that the streptomycin sulfate treatment can control seed-piece decay caused by the blackleg organism under field conditions.

## Conclusions

Treating cut seed potatoes in solutions of streptomycin sulfate or of streptomycin sulfate combined with terramycin hydrochloride is an effective method for reducing the losses from blackleg and from seed-piece decay or missing hills caused by *E. atroseptica* and *P. fluorescens*.

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# THE EFFECT OF IMMERSION IN SEA WATER ON THE SPROUTING OF POTATO TUBERS[1]

J. I. G. Ross[2] and D. B. Robinson[3]

## Introduction

Potato shippers in the Maritime Provinces are often concerned over the possible injurious effects from the wetting of cargoes of potatoes with sea water during transit. Besides the loss that may occur from rot, the question of viability of potato seed stocks following such wetting during ocean transportation is of prime importance. This paper reports the results of experiments conducted to determine the tuber injury that may result when potatoes are drenched or immersed in sea water.

## Materials and Methods

Sea water used in the tests was collected immediately before use during high tides from points on the coast where no run-off or other adulteration could occur. Its specific gravity was found to vary from 1.016 to 1.020. Fresh water used for controls had a specific gravity of 1.001. The potatoes used were of Foundation seed grade and were selected for uniformity and soundness. The effect of the various treatments on the viability of eyes was measured by setting tubers or single eyes in damp moss and then measuring the length of the developing sprouts after two or three weeks.

## Experimental Procedures and Results

A preliminary trial on the effect of immersing tubers in water was performed in the greenhouse at a temperature of 65-70°F. Dormant Sebago tubers, in lots of ten each, were kept in sea water and in fresh water respectively for periods of approximately five days. Control lots were left dry. Observations on the length of tuber sprouts, made at intervals over a period of three weeks, showed that all the immersion treatments promoted growth, and that sea water was slightly more effective than fresh water in this respect. Rot developed within a week, however, in tubers that were kept for more than one day in fresh water or more than three days in sea water.

To confirm and extend the results of this preliminary trial an experiment was designed to test the effect of intermittent drenching with sea water at several temperatures on the viability of seed tubers. Irish Cobbler, Bliss Triumph, Katahdin, and Sebago varieties were included since these are commonly shipped by boat from the Maritime Provinces in the early fall months. A split-plot, randomized block design was used. Each 'sub-lot' comprised twenty tubers and all treatments were replicated four times. Varieties were harvested on October 7 and immediately placed in storage at the designated temperature. One-half of each varietal replicate was then drenched intermittently with sea water for a period

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of four days and allowed to dry. Jute sacks were used as containers so that the 'wet' treatments dried out very gradually over a period of two months. After five weeks storage at the various temperatures all lots were transferred to storage at 40° F. for an additional six weeks. At the end of this period their viability was tested by measuring the growth made by eye-end sprouts when embedded in damp moss for three weeks. The results are summarized in table 1. Samples of all treated lots used in the test were kept in normal potato storage for a full seven months without any adverse effects appearing in those lots that had undergone treatment.

Analysis of variance of the data showed that highly significant differences in growth were caused by variety and by treatment. Wetting with sea water during early storage resulted in greater subsequent growth over the full range of temperatures used. This increase in growth was most apparent in the varieties Sebago and Katahdin where dormancy is less prolonged than in the varieties Irish Cobbler and Bliss Triumph.

TABLE 1.—*The effect of wetting with sea water at various temperatures on the subsequent sprouting of potato tubers.*

| Early Storage Temperature (°F.) | Treatment Dry, or Wet with Sea Water | Average Growth of Sprouts (Mm.) | | | |
|---|---|---|---|---|---|
| | | Irish Cobbler | Bliss Triumph | Katahdin | Sebago |
| 60 | Dry | 4.4 | 4.7 | 8.4 | 12.1 |
| | Wet | 4.8 | 4.7 | 8.7 | 14.1 |
| 70 | Dry | 4.8 | 4.1 | 8.1 | 11.2 |
| | Wet | 5.3 | 5.2 | 9.3 | 14.5 |
| 80 | Dry | 5.5 | 5.6 | 9.5 | 11.5 |
| | Wet | 5.7 | 5.8 | 9.7 | 12.8 |

A second experiment was conducted to determine the relationship of tuber dormancy to sea water effects. One hundred and twenty tubers of the variety Sebago were kept at 68° F. for eight days until the eyes of the eye-end showed signs of growth. They were then divided into two lots. One lot was immersed in sea water whereas the other was left dry. An equal number of completely dormant Sebago tubers were treated similarly. At the end of three days one-half of each group was withdrawn and placed in damp moss to sprout. After six days the remainder was similarly placed in moss. An examination ten days later showed that severe injury and retardation of growth occurred in eyes at the eye-end of the immersed tubers that had begun to break dormancy. No such injury was evident in tubers that were dormant at the time of immersion in sea water. Growth comparisons are given in table 2.

One of the most noteworthy effects observed in this trial was the uniform, vigorous sprouting from all center and stem-end eyes of tubers that had been immersed in sea water. Lots that had been kept dry, even though at green-house temperatures for two weeks, showed sprouting at the eye-end only. The increased early growth of plants originating from stem-end eyes of tubers that had been immersed in sea water is shown in figure 1.

FIGURE 1.—The effect of immersion in sea water on the early growth of stem-end eyes of Sebago tubers. Left—Check; Right—Immersed for six days in sea water.

A final test was performed to determine the length of time that dormant tubers could be immersed in sea water before breakdown of tissue occurred. Six lots of ten tubers each were placed in sea water for one to six days respectively. A similar series was placed in fresh water as a check. All lots were kept at 56°F. Examinations for rot were made twelve days after removal from the water. Comparative counts of bacteria present in the sea water and in the fresh water were also made at intervals during the course of the trial using the method of dilution plating on beef-extract peptone agar adjusted to pH 7.2 and incubated at 22° C. (2). Results are given in table 3.

It is apparent from the table that bacterial populations were several times greater in fresh water than in sea water, and that this was paralleled by more severe rot in the fresh water series. Tubers continuously immersed in sea water for periods up to three days at 56° F. developed no rot, whereas those immersed in fresh water showed severe breakdown after two days of treatment. All eyes not affected by rot sprouted normally. Figure 2 illustrates the type of breakdown that occurred.

TABLE 2.—*The effect of immersion in sea water on the eye-end sprouting of potato tubers.*

| Period Immersed — Days | Average Length of Eye-End Sprouts (mm) | |
|---|---|---|
| | Tubers Dormant | Tubers Breaking Dormancy |
| 0 | 4.4 | 4.7 |
| 3 | 4.2 | 4.4 |
| 6 | 5.2 | 0.7 |
| L.S.D. P = 0.05 | 1.2 | |

TABLE 3.—*The effect of continual immersion in water on rot development of tubers and bacterial population of the water.*

| Period Immersed — Days | Sea Water | | Fresh Water | |
|---|---|---|---|---|
| | Degree of Rot | Number of[1] Bacteria/cc. | Degree of Rot | Number of[1] Bacteria/cc. |
| (Plating of freshly collected water) | | 22 | | 73 |
| 1 | None | 240,000 | None | 730,000 |
| 2 | None | | Severe | |
| 3 | None | 290,000 | Severe | 800,000 |
| 4 | Slight | | Severe | |
| 5 | Slight | | Severe | |
| 6 | Severe | 100,000 | Severe | 740,000 |

[1] Average of six platings.

## DISCUSSION

The results of these trials show that several distinct effects are produced in potato tubers when they are immersed in sea water. Intermittent wetting or continual immersion up to three days at a temperature

FIGURE 2.—Rot caused by immersion for 2 days in fresh water.

of 56°F. promoted the vigor and speed of subsequent sprouting in dormant tubers. On the other hand, eyes that had begun to sprout before treatment were killed or retarded in growth by immersion in sea water. The reduction of oxygen supply attendant on immersion may hasten the termination of the dormant period, as suggested by Thornton (3), and so give the increased early growth observed in dormant-treated lots. Another possible factor is that sea water itself may exert a mild therapeutic action. This is suggested by the much lower levels of bacterial population that occurred in sea water as compared with the fresh water checks, as shown in table 3. Such therapeutic action of sea water was noted in very early times when salvaging wheat from wrecked vessels (1).

## SUMMARY

Immersion of dormant potatoes in sea water for periods up to three days at 56° F. was found to shorten the dormancy period and increase the early growth of plants. More prolonged immersion, or the exposure of eyes that had begun to grow, resulted in a soft rot of tubers and injury to the sprouts.

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# PUNGO:[1] A NEW VARIETY OF POTATO RESISTANT TO LATE BLIGHT AND ADAPTED TO EASTERN VIRGINIA

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For more than fifty years eastern Virginia has produced potatoes for the second early or summer market. In the twenties plantings reached a peak of more than 100,000 acres in the 4 or 5 coastal counties, and all farming activities centered around the potato crop. At that time the most productive land was reserved for potatoes, and the fertility was guarded by suitable rotation systems, the use of winter cover crops, and the application of liberal amounts of stable manure. These treatments on the sandy loams of these counties resulted in the production of bright-looking, high-quality tubers, and their appearance classified them as "new" potatoes as differentiated from the storage potatoes of the North. The new potatoes readily found receptive and widely scattered markets in June and July.

At present about 25,000 acres are planted to potatoes in eastern Virginia. The Virginia crop meets strong competition from the crops of Western States. The present problem, therefore, is to find more efficient means of producing and marketing potatoes. Machine handling, irrigation wherever possible, more effective marketing procedures, and especially the production of higher yielding disease-resistant varieties will do much to meet the competition from other states and keep the industry on a profitable basis.

For many years the Irish Cobbler has been the standard variety in eastern Virginia. It has produced many profitable crops, but under adverse climatic conditions its yields are relatively low, its market quality is often below average, and it is very susceptible to the late blight fungus.

In recent years the Virginia Truck Experiment Station has cooperated with the United States Department of Agriculture in the National Potato-Breeding Program in an effort to find a variety to replace Irish Cobbler. Such a variety should mature its tubers early or medium early and they should have good market and cooking qualities. It would be more valuable if it outyielded Irish Cobbler under adverse conditions and if it were resistant to some of the more serious diseases of potatoes, including late blight.

Late blight does not attack consistently the early crop, but it does occur often enough to cause serious trouble, and the losses from it seem to be increasing, especially in fields that are irrigated. Potatoes planted in July are attacked nearly every year, and frequently the plants are killed before satisfactory yields are made. Few potato growers have the proper equipment to apply fungicidal treatment to control blight, and therefore it seems essential to develop resistant varieties. Many

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Pungo is the name of a well-known Indian Chief, who lived in Princess Anne County, Va., near what is now a noted shipping point for potatoes called Pungo. Many markets are familiar with potatoes shipped from Pungo, Va.

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seedling varieties have been tested, but few of them meet the requirements. One of the most promising was named Pungo and released to growers in 1950.

## Origin

Pungo was tested under the pedigree number B 76-43. It is a selection from the cross of two unnamed seedlings of the United States Department of Agriculture, 96-44 and 528-170. The cross was made and the seedlings were grown in 1940 in the greenhouse of the Plant Industry Station, Beltsville, Maryland. Tubers were sent to Maine for increase. B 76-43 was selected in the fall of 1941, increased further, and sent to various State agricultural experiment stations for trial in 1943. The complete pedigree of Pungo follows:

Pungo (U.S.D.A. Seedling B 76-43)
- X 528-170
  - 44537 x Richter's Jubel
  - x
  - Katahdin x Chippewa
- x
- X 96-44
  - Earlaine x 3895-13

## Description

PLANTS.—Large, spreading. *Stems:* Medium thick, prominently angled. *Nodes:* Slightly swollen, green. *Internodes:* Green. *Wings:* Slightly waved to straight, green. *Stipules:* Medium-sized, green, scantily pubescent. *Leaves:* Medium long, broad, open type, medium green. *Midribs:* Green, scantily pubescent. *Petioles:* Green. *Primary leaflets:* Ovate, medium, 3 pairs, mean length of blade 57.4 $\pm$ 0.53 mm. (2.26 in.), mean width 34.6 $\pm$ 0.36 mm. (1.36 in.), index 60.3 $\pm$ 0.33.[1] *Secondary leaflets:* Few, between primary leaflets. *Tertiary leaflets:* Few. *Inflorescence:* Medium-branched. *Leafy bracts:* Few. *Peduncles:* Medium long, green, scantily pubescent. *Pedicels:* Medium to short, green, scantily pubescent.

FLOWERS.—*Calyx lobes:* Tips medium long, green, scantily pubescent. *Corolla*: Large or medium (diameter 35 mm.), white. *Anthers*: Orange yellow. *Pollen:* Scant. *Style:* Straight. *Stigma:* Globose, multilobed, green.

TUBERS.—Elliptical to elliptical round, mean length 83.2 $\pm$ 0.63 mm. (3.27 in.),[2] mean width 78.1 $\pm$ 0.41 mm. (3.07 in.), mean thickness 61.5 $\pm$ 0.41 mm. (2.42 in.), index of width to length 94.3 $\pm$ 0.94,[3] of

[1] Calculated by dividing the width of each of 100 leaflets by the length and multiplying the average of these ratios by 100. The leaflets were taken from the fourth leaf from the top of a stem, one leaflet, the distal left lateral, being taken from each leaf. Since the potato leaflet is asymmetrical the length was determined by taking the average of the measurements from the apex to the base of each respective lobe. This is a modification of the method described in Salaman, R. N.: Potato Varieties, pages 153-170. Cambridge, 1926.

[2] Average of measurements of 74 tubers each weighing approximately 8 ounces (223-233 gms.).

[3] Calculated by dividing the width of each of 74 tubers by the length and multiplying the average of these ratios by 100. The data used for calculating the index were taken from the measurements used to designate the dimensions of the tubers.

thickness to length 74.3 ± 0.79, of thickness to width 79.0 ± 0.70. *Skin:* Flaked, self-colored, dark creamy buff. *Eyes:* Medium deep, of same color as skin. *Eyebrows:* Medium long, curved, medium prominent. *Flesh:* White. *Sprouts:* Creamy white when developed in the dark. *Maturity:* Early in Virginia, medium early in Maine.

## Characteristics

Pungo is a rapidly growing early to medium-early variety. The tubers are elliptical to elliptical round with medium deep eyes and dark creamy buff skin classified as white in the commercial trade.

In eastern Virginia the seedling varieties are tested under a wide range of environmental conditions. Some of the tests are made at Norfolk, Virginia, in the spring under irrigation and others without irrigation. The soil at Norfolk is fairly heavy, not typical of the soils used to grow the very early commercial potatoes in that district, but a type capable of producing optimum yields. Other tests are made at Onley, Virginia, on soil fairly representative of that on which many of the potatoes are grown on the Eastern Shore. The test plots at Onley are not irrigated; so in seasons of light rainfall the potato yields are low. Potatoes for another test are planted at Norfolk in July and harvested in early November. A variety that will perform satisfactorily under such a wide range of conditions is unusual.

In 1949 Pungo was harvested at Norfolk, Virginia, as early as the Irish Cobbler, and it yielded 26 per cent higher. It showed a degree of drought resistance in the tests at Onley, where with rainfall of approximately 10 inches during the growing season it yielded 77 per cent higher than the Irish Cobbler.

In 1953, 9 trials were made in eastern Virginia. Under irrigation at Norfolk, Virginia, Pungo yielded 365 bushels per acre and Irish Cobbler 341. Without irrigation Pungo produced 230 bushels per acre and Irish Cobbler 200. In 8 of the 9 tests Pungo produced larger yields than Irish Cobbler. The average yield of Pungo for the 9 tests was 310 bushels per acre compared with 280 bushels for Irish Cobbler. In soil heavily infested with the scab organism 66 per cent of the total yield of Pungo, or 248 bushels per acre, was marketable, but only 16 per cent, or 40 bushels, of Irish Cobbler was marketable. In an insect-preference test flea beetles and leafhoppers were much less injurious to the Pungo than to the Irish Cobbler.

Although eastern Virginia can produce excellent table stock it is extremely difficult to grow satisfactory seed stock there. As a result, Virginia must depend on Maine or other Northern States for seed potatoes, and so a variety grown in Virginia must yield enough in the Northern States to pay growers to provide certified seed.

Pungo meets this requirement. In 24 tests at 6 places in Maine during 1947 to 1950, Pungo yielded 647 bushels per acre compared with 640 for Green Mountain and 533 for Katahdin. In these same tests Pungo produced a mean dry-matter content of about 18.0 per cent and Green Mountain about 18.8.

Pungo is highly resistant to the common races of the late blight fungus. It has shown this resistance in the Norfolk area and in Maine.

In 1951, a year of heavy losses from late blight in Maine, it yielded 604 bushels per acre of U. S. No. 1 potatoes without spray of any kind, compared with a yield of 495 bushels for Green Mountain. When sprayed with DDT alone to kill insects Pungo yielded 655 bushels per acre and Green Mountain 537, but when sprayed with bordeaux + DDT Pungo yielded 647 bushels per acre and Green Mountain 645. The blight resistance of Pungo is reflected in these data.

## Adaptation and Comparisons

In eastern Virginia, Pungo is more suitable for the spring planting than Kennebec or Sebago, as it matures at approximately the same time as Irish Cobbler. Kennebec and Sebago mature at least two weeks later and for this reason are recommended for the late crop planted in July and harvested in November.

Pungo has been tested for adaptation by the National Potato-Breeding Program. It was included in a group of more than 400 selections, single tubers of which were sent to 20 cooperating State agricultural stations for the 1943 crop. A number of the cooperators selected it for further trial. Since 1943 it has been sent out in large lots, and the results show that it yields well in a number of Southern States. In 1949 at four places in South Carolina Pungo gave a mean yield of 334 bushels per acre and Irish Cobbler 244. At two places in Florida, Pungo yielded 396 bushels per acre and Sebago 326. At Russeltown, Texas, Pungo yielded 155 bushels per acre, and Triumph 65. At Thibodaux, Louisiana, Pungo yielded 245 bushels per acre and Triumph 135. From these and other records it is evident that Pungo yields satisfactorily in a number of Southern States.

Under very favorable growing conditions, such as prevailed in Maine in 1951, Pungo produces too many large tubers, and the very large tubers are inclined to be rough. This is true also of other vigorous-growing varieties such as Kennebec and Sequoia. Closer planting and lighter applications of fertilizer will remedy this condition without reducing yield much and with the added advantage of a saving in the cost of fertilizer.

## Dissemination

In 1953 a carload of certified seed of Pungo was distributed among the growers in eastern Virginia. Most of them reported that the new variety was superior to Irish Cobbler in yield and market qualities. The results of experimental tests and the favorable reports from growers should create a demand for certified seed of Pungo. A limited acreage of this variety was entered for certification in Maine in 1953 and it was reported that a small amount was produced in Canada.

## Summary

About 25,000 acres are planted to potatoes, annually, in eastern Virginia. New production methods and new high-yielding disease-resistant varieties must be used if the Virginia potato industry is to meet the competition from other states. As part of the National Potato-Breeding

Program, Pungo, a rapidly growing, medium-early variety, potentially high in yielding ability and highly resistant to the late blight fungus, was released to growers in 1950. Pungo usually outyields Irish Cobbler and far exceeds it on the Eastern Shore of Virginia in seasons of deficient rainfall.

It compares favorably with Green Mountain in Maine so that it can be produced with profit by certified seed growers. It can be grown in Maine without fungicidal applications but should be sprayed with DDT.

Pungo yields well in several of the southern states. If its tubers grow too large they are inclined to be rough. Closer planting and lighter applications of fertilizer will remedy this condition.

## POTATO NEWS AND REVIEWS

# POTATO UTILIZATION IN RELATION TO VARIETY (HEREDITY) AND ENVIRONMENT[1]

F. J. STEVENSON,[2] R. V. AKELEY[2] AND JOHN G. MCLEAN[2]

Potato utilization is a subject that is freely discussed especially in years of surplus. Utilization in its broadest sense includes the use made of potatoes whether consumed in the fresh state, processed before they reach the ultimate consumer, fed to live stock, used for seed, or exported, and regardless of the way in which potatoes are utilized, variety, and the environment in which the potatoes are grown play important parts.

In 1952 the total potato production in the United States was 347.5 million bushels. Three and two-tenths million bushels were imported, making a total supply of 350.7 million bushels (1). Roughly, 74 per cent of the total supply, or 259.1 million bushels, were used fresh: 6 per cent in farm homes, 51 per cent in urban homes, and 17 per cent in restaurants. The total amount processed before reaching the ultimate consumer was approximately 35 million bushels, or nearly 10 per cent of the total supply. Feed for livestock and shrinkage amounted to approximately 19 million bushels, or a little over 5 per cent. About 34 million bushels or 10 per cent were used for seed and 3.5 million bushels, or 1 per cent, was exported. It might be noted that in 1952 the amount imported, 3.2 million bushels, was very close to the amount exported, 3.5 million bushels. The data on potato utilization in the United States in 1952 adapted from a table prepared by A. E. Mercker, United States Department of Agriculture, published by William M. Case in the *Valley Potato Grower* are given in table 1.

### VARIETY

Varieties of potato differ in many characters such as color of skin, shape of tuber, depth of eye, color of flesh, chemical composition, physical structure of flesh, yield, and reaction to diseases and injury by insects. Each character is dependent on hereditary factors or genes present in each of the cells of the potato, but the development of each character is influenced by the environment which makes or mars it even when the most desirable combination of genes is present.

The potato geneticist has a relatively easy task in producing varieties with favorable combinations of genes and much progress can be shown in the varieties recently released to growers, but no variety has ever been produced that will have the same qualities grown under all environmental conditions.

If it were not for environmental effects or if all potatoes were grown under the same environment it would be easy to name varieties most suitable for various methods of cooking, such as baking, boiling, chipping, or french frying. However, potatoes are grown in the United States under a wide range of environments and the variety name in itself has little value in designating a potato for a particular purpose.

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TABLE 1.—*Potato utilization in the United States in 1952.*

| Potato Use | Millions of Bushels | Per cent of Total Supply |
|---|---|---|
| *Fresh Food* | | |
| On farms where produced | 20.3 | 5.79 |
| In urban homes | 178.8 | 50.98 |
| In restaurants | 60.0 | 17.11 |
| Total used fresh | 259.1 | 73.88 |
| *Processed Foods and Starch* | | |
| Chips | 25.3 | 7.21 |
| Frozen french fries | 2.5 | .71 |
| Hash, stews, soups | 1.0 | .28 |
| Canned potatoes | 1.4 | .43 |
| Dehydrated potatoes | 1.2 | .34 |
| Flour | .4 | .11 |
| Starch | 3.1 | .88 |
| Total processed | 34.9 | 9.96 |
| *Feed* | | |
| For livestock | 18.9[1] | 5.39 |
| *Seed* | | |
| For new crops | 34.3 | 9.78 |
| *Exports* | | |
| To foreign countries | 2.5 | .71 |
| To territories of United States | 1.0 | .28 |
| Total off-shore sales | 3.5 | .99 |
| Total supply | 350.7[2] | 100.00 |

[1]This value includes some shrinkage or loss.
[2]The total supply includes a production of 347.5 million bushels, and imports 3.2 million bushels, a total of 350.7 million bushels.

In recent years more potatoes than formerly are processed before being sold to the ultimate consumer and greater attention is being given to the production of varieties suitable for processing. Varieties to be processed are not unlike those to be used fresh. They must have about the same characteristics. A list of the important characters must include

high yield, disease resistance, smooth tuber shape, shallow depth of eye, and a high percentage of solids. High yields and disease resistance cut costs of production and consequently the cost of the raw material to the processor.

Smooth shape and shallow eyes eliminate much waste in the preparation of potatoes for processing, especially if they are prepared with a mechanical peeler. Kirkpatrick *et al.* (2) reported losses in 6 commonly grown varieties of potatoes from machine-paring. The mean percentages of loss for 4 years are given in table 2. The losses ranged from 20.2 per cent in Katahdin to 31.7 per cent in Irish Cobbler. It would take a large difference in percentage of solids to offset this difference in paring waste. These losses are from the outer layers of flesh, which are usually higher in dry matter and contain a larger proportion of vitamins and minerals than the inner tissues.

Fortunately, all processors want potatoes containing high percentages of solids. Other characters, such as sugar content, amino acids, and proteins, may make or mar the finished product, but high dry-matter content is a prime necessity for the makers of starch, flour, dehydrated potatoes, frozen french fries, and potato chips. Fortunately, again, we have a simple test for solids since this percentage can be estimated from the specific gravity of the tubers.

TABLE 2.—*Percentage losses of potatoes obtained by machine-paring of 6 varieties during the years 1947 to 1950, inclusive.*

| Variety | Mean Loss[1] (4 years) |
|---|---|
| | Per cent |
| Katahdin | 20.2 |
| Russet Burbank | 20.4 |
| Chippewa | 25.1 |
| Triumph | 28.1 |
| Green Mountain | 29.0 |
| Irish Cobbler | 31.7 |

[1]Data adapted from an article written by Kirkpatrick *et al.* (2).

## INHERITANCE OF PERCENTAGE SOLIDS

The character percentage solids in potatoes, like all other genetic characters, is the end result of the interaction of hereditary factors or genes and of environment. The plant breeder can get new recombinations of genes and produce varieties that have relatively high dry-matter contents when grown in a particular environment, but when grown elsewhere or in another season they may be much lower in their percentage of solids.

A study of the inheritance of high *versus* low solids was made with 5 varieties: seedling variety 47156, high in percentage solids; Katahdin, medium high; Earlaine, medium low; Earlaine No. 2 low; and Green Mountain, high. The first 4 were selfed and all were crossed with Green Mountain. The data for the selfed lines are given in table 3.

TABLE 3.—*Segregation for percentage solids found in four selfed lines of potato grown at Presque Isle, Maine, 1943.*

| Parentage | Solids in Parents | Range of Solids in Seedlings | Mean Solids in Seedlings | Seedlings[1] with 19.7 Per cent Solids or Higher | Seedlings Tested |
|---|---|---|---|---|---|
| | Per cent | Per cent | Per cent | Per cent | No. |
| 47156 selfed | 23.3 | 16.6-23.0 | 20.3 | 66 | 35 |
| Katahdin selfed | 21.0 | 15.5-22.2 | 18.9 | 31 | 81 |
| Earlaine selfed | 19.0 | 15.0-20.5 | 17.8 | 10 | 44 |
| Earlaine No. 2 selfed | 17.6 | 15.0-19.1 | 16.8 | 0 | 38 |

[1]19.7 per cent solids is equal to 1.080 specific gravity. Specific gravity 1.080 or higher is preferred by the makers of chips or french fries.

*Selfed Lines.* The seedlings in each of the 4 selfed lines showed a wide range in percentage solids indicating that none of the parent varieties bred true. The percentages of seedlings meeting the preferences of the chip makers, 19.7 per cent solids or higher, were in the same order as the solids of the parent varieties: 66 per cent of the seedlings of 47156 selfed, 31 of Katahdin selfed, 10 of Earlaine selfed, and 0 per cent of Earlaine No. 2 selfed showed 19.7 per cent solids or higher. The data show that percentage solids is inherited.

*Crosses.* Further evidence of the heritability of percentage solids is found in the segregations in 4 potato crosses as shown in table 4. Some of the seedlings of the first 2 crosses were higher in percentage of solids than either parent. In the last 2 crosses the dominance of the high

TABLE 4.—*Segregation for percentage solids found in four potato crosses grown at Presque Isle, 1943.*

| Crosses | Solids in Parents | Range of Solids in Seedlings | Mean Solids in Seedlings | Seedlings[1] With 19.7 Per cent Solids or Higher | Seedlings Tested |
|---|---|---|---|---|---|
| | Per cent | Per cent | Per cent | Per cent | No. |
| Green Mountain x S 47156 | 23.8 x 23.3 | 18.9-25.5 | 22.6 | 97 | 117 |
| Green Mountain x Katahdin | 23.8 x 21.0 | 18.3-24.7 | 21.2 | 89 | 94 |
| Green Mountain x Earlaine | 23.8 x 19.0 | 15.6-23.8 | 20.1 | 61 | 94 |
| Green Mountain x Earlaine No. 2 | 23.8 x 17.6 | 16.4-23.3 | 19.6 | 53 | 94 |

[1]19.7 per cent solids is equal to 1.080 specific gravity. Specific gravity 1.080 or higher is preferred by makers of chips or french fries.

percentage solids in Green Mountain is evident since several of the seedlings in the cross Green Mountain x Earlaine were as high as the Green Mountain parent, and a few of those in the cross Green Mountain x Earlaine No. 2 were nearly as high as the better parent.

In selfed lines and crosses it is evident that if one parent is high in percentage solids a large number of the progeny will also be high, but if both parents are low as was the case when Earlaine No. 2 was selfed none of the seedlings was high enough to meet the preference of the makers of chips or french fries.

Varieties that were high in dry-matter content when grown in plots on the Aroostook Farm, Presque Isle, Maine, in 1943, were produced, but when they are grown elsewhere or in another season the results might be different because of environmental effects.

## Environmental Variations Affecting Percentage of Solids

It has been shown that there are genetic differences among varieties and seedlings in their ability to produce a high percentage of solids, but often the differences due to environment are greater than the genetic or varietal differences. Many environmental factors will influence the development of dry-matter content in the potato, but only a few will be discussed in this paper: soil variation, locations in Maine, locations in 17 States, optimum conditions in Idaho, unfavorable conditions in Idaho, date of planting in Maine, date of killing potato tops or harvesting in Maine, fertilizer, and temperature and moisture.

*Soil Variation.* The tubers of a single variety grown in a short row will show wide differences in percentage of solids. The 5 varieties used as parents of the crosses reported in table 4 were grown from seed-pieces at Presque Isle, Maine, in 1943. Tubers were selected at random from 3 replications of 25 hills each. The data for percentage solids of these tubers are presented in table 5. A wide range in percentage solids was found in the samples of each variety. The lowest and the highest dry-matter content found in the tubers of the Green Mountain variety differed by 10.6 per cent. However, the percentages of tubers with 19.7 per cent solids show these 5 varieties to rank as follows: Green Mountain, seedling variety 47156, Katahdin, Earlaine, and Earlaine No. 2.

*Locations in Maine.* In 1952 yield and specific gravity tests were conducted at four locations in Maine, in cooperation with the Maine Agricultural Experiment Station. The potatoes were planted at Presque Isle on May 6, and about 3 weeks later at the other 3 locations. They were harvested at Presque Isle on September 20 and about a week later at the other places. These planting and harvesting dates are not unusual for the locations in which the tests were made, so it might not be too far wrong to say that the differences in percentage solids for the 9 varieties shown in table 6 were due to location. It will be noted that the greatest difference due to location was higher for each variety than the greatest difference between varieties grown at any one place. Ontario, the variety lowest in the test at Presque Isle, was higher in percentage solids when grown there than Green Mountain or any of the other varieties grown at Pittsfield or Exeter, Maine. In this case then, the environment had a greater influence than the genetic constitution of the variety.

TABLE 5.—*Variation in percentage solids of five varieties of potato due to soil variation found in 3 replicated plots of 25 hills each, Presque Isle, Maine, 1943.*

| Variety | Tubers in Sample | Range of Solids | Mean Solids | Tubers with Solids 19.7 Per cent or Higher |
|---|---|---|---|---|
| | No. | Per cent | Per cent | Per cent |
| Green Mountain | 30 | 16.5-27.1 | 23.8 | 93 |
| Seedling 47156 | 30 | 17.6-26.1 | 23.3 | 90 |
| Katahdin | 28 | 16.5-23.9 | 21.0 | 89 |
| Earlaine | 29 | 15.0-21.7 | 19.0 | 45 |
| Earlaine No. 2 | 30 | 15.0-20.7 | 17.6 | 20 |

TABLE 6.—*Solids in 9 varieties of potatoes grown at 4 locations*[1] *in Maine, 1952.*

| Variety | Solids in Potatoes Grown at — | | | | Greatest Difference in Solids |
|---|---|---|---|---|---|
| | Pittsfield (May 26-Sept. 25) | Exeter (May 27-Sept. 26) | Sherman (May 28-Sept. 29) | Presque Isle May 6-Sept. 30 | |
| | Per cent | Per cent | Per cent | Per cent | Per cent |
| Irish Cobbler | 16.2 | 17.7 | 19.2 | 21.9 | 5.7 |
| Green Mountain | 15.6 | 17.4 | 19.9 | 21.8 | 6.2 |
| Katahdin | 14.5 | 16.7 | 17.7 | 19.9 | 5.4 |
| Kennebec | 14.6 | 15.7 | 18.2 | 19.9 | 5.3 |
| Cherokee | 15.0 | 17.7 | 19.4 | 21.8 | 6.8 |
| Triumph | 14.4 | 16.5 | 16.2 | 20.4 | 6.0 |
| Ontario | 14.0 | 14.8 | 16.7 | 18.2 | 4.2 |
| Pungo | 15.0 | 16.7 | 19.9 | 20.9 | 4.9 |
| Early Gem | 14.7 | 16.5 | 16.9 | 19.9 | 5.2 |
| Greatest diffenence in solids | 2.2 | 2.9 | 3.7 | 3.7 | |

[1]These locations represent different environmental conditions of potato-growing areas in Maine.

*Locations in 17 States.* In 1952 Irish Cobbler and Katahdin potatoes were compared for yield and specific gravity in 17 states. Many other varieties were included in the various tests, but these two are compared because Irish Cobbler is the most widely grown early, and Katahdin the most widely grown late variety.

The data for the percentage solids found in these two varieties, as computed from the specific gravity readings, are found in table 7. These data show again that differences due to location are far greater than the

TABLE 7.—*Percentage solids in 2 varieties of potato grown in 17 states in 1952.*

| State | Solids in | | Differences in Solids between Varieties |
|---|---|---|---|
| | Irish Cobbler | Katahdin | |
| | Per cent | Per cent | Per cent |
| Maine | 20.9 | 19.0 | 1.9 |
| North Dakota | 20.4 | 20.8 | .4 |
| Minnesota | 20.4 | 20.7 | .3 |
| Wisconsin | 20.4 | 21.3 | .9 |
| Michigan | 17.4 | 17.3 | .1 |
| Iowa | 18.3 | 17.2 | 1.1 |
| Nebraska | 20.2 | 21. 1 | .9 |
| Connecticut | 16.7 | 17.2 | .5 |
| Delaware | 16.0 | 15.6 | .4 |
| Massachusetts | 16.6 | 16.5 | .1 |
| New Hampshire | 18.2 | 17.3 | .9 |
| New Jersey (2 tests) | 17.0 | 16.0 | 1.0 |
| New York (7 tests) | 18.2 | 17.9 | .3 |
| Pennsylvania (5 tests) | 17.6 | 17.9 | .3 |
| Rhode Island | 16.7 | 15.6 | 1.1 |
| West Virginia | 19.0 | 18.9 | .1 |
| Wyoming | 19.6 | 18.5 | 1.1 |
| Mean | 18.4 | 18. 2 | |
| Greatest Difference | 4.9 | 5.7 | |

difference between the two varieties grown at any one place. There was no significant difference between the means of the two varieties for all locations, but the differences between states were highly significant for both varieties.

The data in table 7 show the fallacy of comparing two varieties if they were not grown under the same environmental conditions, a mistake that is often made. They emphasize, too, how erroneous conclusions can be drawn about the quality of a variety by testing only a few samples. They show, furthermore, that the variety name alone offers no criterion for judging the percentage of dry matter. The Irish Cobbler, as grown on the Aroostook Farm, Maine, in 1952, with 20.9 per cent solids, is quite different from Irish Cobbler grown in some of the other states with approximately 16.0 per cent solids. No such differences are found between the two varieties grown in any one of the states.

*Optimum Conditions in Idaho*. Many people are of the opinion that Idaho potatoes are usually high in dry-matter content only because the Russet Burbank is grown there, but under the most favorable conditions

in that state many varieties produce tubers high in percentage solids. The data for percentage solids for 13 varieties grown at Aberdeen, Idaho, in 1950, are given in table 8. All 13 varieties in the test were high in dry-matter content and several showed higher percentages of solids than Russet Burbank. The flesh of any of the 13 was dry enough to be acceptable for baking, chipping, or french frying. Katahdin, considered medium high in dry-matter content in Maine, ranked second with 25.0 per cent solids. In 1950 in another test 66 named or numbered American varieties were grown at Aberdeen. These varieties ranged in solids from 16.3 to 27.4 per cent with a mean of 22.3. The tubers of 62 of these were high enough in dry-matter content to meet the preference for baking, chipping, and french frying. Thirty-two of them were higher in percentage solids than the Russet Burbank shown in table 8.

A number of other tests in Idaho show that potatoes grown under irrigation not only at Aberdeen, Idaho, but also at Lewiston and Parma, Idaho, were high in percentage solids, but in one test on dryland at Tetonia, Idaho, the results were quite different.

*Unfavorable Conditions in Idaho.* In 1951, five varieties were grown on dryland at Tetonia, Idaho. The data on percentage solids for this test are given in table 9. Russet Burbank produced 15.5 per cent solids, the equivalent of approximately 10 per cent starch. The percentages for the other 4 varieties were slightly lower.

The conditions under which this test was grown were extremely unfavorable. The plots were grown on dryland. There was a shortage of rainfall during the spring and early summer. Heavy rains occurred in

TABLE 8.—*Percentage solids in 13 varieties of potato grown at Aberdeen, Idaho, in 1950.*

| Variety | Solids |
|---|---|
| | Per cent |
| Empire | 25.3 |
| Katahdin | 25.0 |
| Menominee | 24.5 |
| Potomac | 24.3 |
| Sequoia | 23.4 |
| Yampa | 22.5 |
| Erie | 22.4 |
| Teton | 22.2 |
| Irish Cobbler | 22.2 |
| Russet Burbank | 22.2 |
| Desota | 22.1 |
| Houma | 21.6 |
| Red Warba | 21.2 |

TABLE 9.—*Percentage solids in 5 varieties of potato grown on dryland at Tetonia, Idaho, 1951.*

| Variety | Solids |
|---|---|
| | Per cent |
| Russet Burbank | 15.5 |
| Early Gem | 15.4 |
| Kennebec | 15.1 |
| Menominee | 14.7 |
| White Rose | 13.9 |

mid-August. After the rain the plants renewed their growth, but they were killed by frost in early September. As a result, the tubers were immature at harvest time and were low in percentage solids. The data in table 9 show that the best varieties will not produce tubers with a high dry-matter content when grown in an unfavorable environment. However, it should not be inferred from the data given that potatoes grown on dryland are low in percentage of solids. On the contrary, if growing conditions are favorable, potatoes grown on dryland may have a high dry-matter content.

*Date of Planting in Maine.* In 1952, eight varieties of potatoes were planted on the Aroostook Farm, Presque Isle, Maine, on May 6, 16, and 26, and on June 5. All were harvested on the same date. The data for percentage solids for this test are given in table 10.

There was a gradual decrease in the means for all varieties for each of the 4 planting dates. The greatest difference found in a single variety was 2.9 per cent for Green Mountain. This was about as large as the greatest difference among the 8 varieties planted on May 6 and larger than the greatest difference among the varieties planted on the other 3 dates.

The data from this and other date-of-planting tests show that early planting is required if a high percentage of dry matter is to be obtained. This is true especially for varieties such as Green Mountain and Kennebec, which require a long growing season if they are to produce tubers high in percentage solids.

*Date of Killing Tops or Harvesting.* In recent years it has become customary in Maine and other states to kill potato tops before the plants are mature. This is done to destroy late blight spores to prevent tuber infection at digging time and to avoid the production of excessively over-sized tubers, to harden up or set the skin on the tubers to lessen bruises, and to prevent late current-season spread of leafroll which may result in net necrosis. On May 6, 1952, 8 varieties were planted on Aroostook Farm, Presque Isle, Maine. Tops of the plants were removed from part of the plot on August 15 and 25, and on September 4. The tops on the plants in the remaining plots were partially killed by frost on September 7 and were almost completely killed by September 14. The tubers from all the plots were harvested on September 22. The data for percentage solids found in these tests are given in table 11.

TABLE 10.—*Solids in 8 varieties of potato planted on four dates but harvested on same date, Presque Isle, Maine, 1952.*

| Variety | Solids in Potatoes Planted on— | | | | Mean Solids | Greatest Difference in Solids |
|---|---|---|---|---|---|---|
| | May 6 | May 16 | May 26 | June 5 | | |
| | Per cent | Per cent | Per cent | Per cent | Per cent | Per cent |
| Irish Cobbler | 20.7 | 19.4 | 19.4 | 18.2 | 19.4 | 2.5 |
| Mohawk | 19.9 | 19.4 | 18.9 | 17.9 | 19.0 | 2.0 |
| Green Mountain | 20.6 | 19.2 | 17.8 | 17.7 | 18.8 | 2.9 |
| Kennebec | 18.7 | 18.2 | 17.9 | 16.7 | 17.9 | 2.0 |
| Katahdin | 18.2 | 17.7 | 17.7 | 17.4 | 17.8 | .8 |
| Teton | 18.7 | 17.9 | 17.8 | 16.2 | 17.7 | 2.5 |
| Chippewa | 17.7 | 17.4 | 17.3 | 16.2 | 17.2 | 1.5 |
| Sebago | 17.7 | 16.9 | 15.9 | 15.7 | 16.6 | 2.0 |
| Mean | 19.0 | 18.3 | 17.8 | 17.0 | 18.0 | 2.0 |
| Greatest difference | 3.0 | 2.5 | 2.5 | 2.5 | | |

TABLE 11.—*Solids in 8 varieties of potato planted on a single date and with tops removed on 4 different dates, Presque Isle, Maine, 1952.*

| Variety | Solids When Tops Were Removed on— | | | | Mean | Greatest Difference in Solids |
|---|---|---|---|---|---|---|
| | Aug. 15 | Aug. 25 | Sept. 4 | Sept. 14[1] | | |
| | Per cent | Per cent | Per cent | Per cent | Per cent | Per cent |
| Irish Cobbler | 19.2 | 20.2 | 20.9 | 20.9 | 20.3 | 1.7 |
| Green Mountain | 17.7 | 19.2 | 20.7 | 19.7 | 19.3 | 3.0 |
| Mohawk | 17.2 | 18.4 | 20.9 | 19.9 | 19.1 | 3.7 |
| Teton | 17.7 | 19.2 | 20.2 | 19.0 | 19.0 | 2.5 |
| Kennebec | 16.2 | 18.2 | 19.0 | 19.2 | 18.2 | 3.0 |
| Katahdin | 15.7 | 17.4 | 19.0 | 18.2 | 17.6 | 3.3 |
| Chippewa | 15.2 | 17.2 | 18.4 | 17.3 | 17.0 | 3.2 |
| Sebago | 14.5 | 16.0 | 18.4 | 17.4 | 16.6 | 3.9 |
| Mean | 16.7 | 18.2 | 19.7 | 19.0 | | |
| Greatest difference | 4.0 | 4.2 | 2.5 | 3.6 | | |

[1]Tops partially killed September 7 and almost completely killed on September 14. All potatoes harvested September 22.

It can be seen from these data that if top-killing is done too early it will be at the expense of dry-matter content in the tubers. When the tops were pulled on August 15 the percentage solids in all varieties except the Irish Cobbler were low. The earliness of the Irish Cobbler

is reflected in the 19.2 per cent solids found in its tubers on the first date of vine pulling.

*Fertilizer.* Many investigators have reported on the differences in dry-matter content in potatoes resulting from kinds of fertilizers and rates of application. Smith and Nash (4) reported on the results obtained with 10 fertiilzer treatments. Tubers from unfertilized plots and from plots fertilized with 5-10-0 (no potassium) averaged higher in dry-matter content than those from any of the other treatments. Tubers from the plot with 5-0-10 (high potassium) were lowest in average dry-matter content. Tubers from plots receiving 5-10-10 fertilizer and given 3 side dressings each of 2 per cent potash and 2 per cent nitrogen were also slightly lower than those of most of the other treatments. Terman *et al.* (5) reported the results of different fertilizer treatments over a period of years. The results from their experiments showed that as the potassium content of the tubers increased the dry-matter content decreased. The reduction in dry matter with increase in potassium was highly significant. The only exception was found on plots having initially a low residue of exchangeable potassium. In this case the addition of a certain amount of potassium increased the dry-matter content.

*Temperature and Moisture.* High temperatures, usually accompanied by a shortage of moisture, when the tubers are forming may result in a crop failure, as occurred in Kansas and in Missouri in 1953, and the tubers that are formed are usually extremely low in dry-matter content.

Tubers with a low percentage of solids were harvested in 1949 in the vicinity of Cranbury, New Jersey. In a letter to the senior author, John C. Campbell, Rutgers University, New Brunswick, New Jersey, wrote: "The growing season that year (1949) was abnormally hot and dry. There was a period of almost 2 months when less than 1 inch of rain fell, and temperatures were also above average. Many of the potatoes in this area were evidently very low in starch content. Excessive losses were experienced by shippers and growers because of a watery breakdown which developed in many shipments. Many of the stored potatoes also broke down in a month or two and the potatoes had to be removed at considerable loss to the owners."

## Foreign Potatoes

The introduction of foreign varieties of potatoes or species of *Solanum* may not appear to be a plant-breeding procedure yet it is fundamental to a well-rounded breeding program. From our experience, it seems improbable that varieties that are adapted to any of the potato-growing regions of the United States will be found in foreign countries except Canada, but even if the new introductions cannot compete with our standard varieties some of them carry genes for certain characters that make them extremely valuable from the breeding standpoint.

The total number of accessions in the record books of the potato project exceeds 25,000. These include commercial varieties, domestic and foreign seedling varieties, and species and true seed of a number of selfed lines and crosses. There are many duplicates but several thousand different sorts have been collected during the past 40 years.

Since 1930 we have received potato materials from approximately

20 foreign countries and have sent seed stocks of various kinds to more than 30 foreign countries.

*Crosses with Foreign Varieties.* Since 1910 hundreds of crosses have been made with foreign varieties or with seedlings grown from true seed sent from foreign countries. Every variety released under the National Potato-Breeding Program is more or less related to foreign introductions. The foreign materials have contributed many characters of value, as have also some of the old American sorts, and we now have varieties and seedlings with combinations of characters never known before. Some of these varieties will be more valuable to the industry of the future than any grown commercially today.

*European Varieties.* It is a common belief that European varieties, especially those grown for starch and alcohol production in Germany, produce a much higher percentage of solids than do American varieties. Table 12 shows the percentage solids found in 17 varieties grown in 1952 (3) in the Bayern district of Germany. It will be noted that these

TABLE 12.—*Percentage solids in 17 potato varieties grown in the Bayern district of Germany, 1952.*

| Variety | Solids[1] |
|---|---|
| | Per cent |
| Robusta | 26.4 |
| Falke | 26.4 |
| Tiger | 25.5 |
| Panther | 25.3 |
| Biene | 24.9 |
| Roswitha | 24.2 |
| Maritta | 24.2 |
| Monika | 23.4 |
| Mittlefrühe | 23.1 |
| Wohltmann | 22.9 |
| Columba | 22.9 |
| Inis II | 22.4 |
| Benedikta | 22.4 |
| Parnassia | 21.9 |
| Suevia | 21.6 |
| Jakobi | 20.2 |
| Ackersegen | 20.2 |
| Mean | 23.4 |

[1]Reported as percentage starch (converted to percentage solids for comparison with data in other tables).

varieties range in solids from 20.2 to 26.4 per cent, with a mean of 23.4 per cent solids or 17.7 per cent starch.

American varieties grown in some sections of the United States would produce a much smaller percentage of total solids than was found in the 17 varieties grown in Germany. However, American varieties grown under favorable conditions, such as those found in some sections of Idaho, will compare favorably with the best of the varieties reported in table 12, as can be seen by a report of 9 varieties grown at Parma, Idaho, in 1953. The data for these are given in table 13. The percentage dry matter for these 9 varieties ranged from 26.3 per cent solids for Menominee to 21.6 per cent for Triumph, with an average of 24.2 per cent for the 9 varieties.

TABLE 13.—*Percentage solids in 9 varieties of potato grown at Parma, Idaho, 1953.*

| Variety | Solids[1] |
|---|---|
| | Per cent |
| Menominee | 26.3 |
| White Rose | 25.5 |
| Russet Burbank | 25.3 |
| B 579-3 | 25.3 |
| Kennebec | 24.3 |
| Red Warba | 24.0 |
| De Soto | 23.5 |
| Early Gem | 21.8 |
| Triumph | 21.6 |
| Mean | 24.2 |

[1]Reported as specific gravity (converted to percentage total solids for comparison with data in other tables).

## DISCUSSION AND SUMMARY

In 1952 the supply of potatoes in the United States was about 350.7 million bushels. Nearly 74 per cent of this supply was used fresh, approximately 10 per cent was processed, and the remainder was used for stock feed, seed, and export. About 25 million bushels were sold for chipping purposes.

Potato varieties to be processed are not unlike those to be used fresh. They must have about the same characters. High yields and disease resistance cut costs of production. Smooth tuber shape and shallow eyes eliminate much waste. Paring wastes ranging from 20.2 per cent for Katahdin to 31.7 per cent for Irish Cobbler have been reported.

All processors prefer potatoes with a high percentage of solids. Solids can be estimated by specific gravity. There are inherent differences among varieties in their ability to produce high dry matter, but often the

differences caused by environment are greater than the genetic differences.

All factors such as soil variation, locations, date of planting, date of harvest, fertilizer, temperature and moisture affect the percentage of solids. Many foreign varieties have been introduced, but none, with the possible exception of one or two from Canada, is adapted to growing conditions in this country. However, the foreign introductions have contributed many characters of value to our breeding program. Some German varieties produce a high percentage of solids when grown in the Bayern district of Germany but a number of American varieties compare favorably with them when grown in Idaho. No variety that will perform the same under all conditions has ever been produced. For this reason it is suggested that potatoes be bought by sample, even if the crop was grown under favorable conditions. The variety name has little value in itself since the same variety, grown under different conditions, can vary so widely. Specific-gravity determinations, from which percentage solids can be estimated, are made easily and the cost of taking the samples and making the determinations will pay the processor worth-while returns.

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## SIXTH POTATO UTILIZATION CONFERENCE SET FOR NOVEMBER

Plans for the Sixth Potato Utilization Conference to be held at Cornell University, Ithaca, N. Y., November 17, 18 and 19, have been confirmed by the program committee. Cornell's invitation was extended by Dr. Ora Smith, Professor of Vegetable Crops, and Research Director of the National Potato Chip Institute.

Begun in 1948 the Utilization Conferences have been held annually at such widely separated points as Philadelphia, Pa.; Albany, Calif.; Grand Forks, N. D.; Denver, Colo. and Beltsville, Md. In addition to the United Fresh Fruit and Vegetable Association, active sponsors of the conference have been USDA's Utilization Research Branch and the Bureau of Human Nutrition, state colleges and experiment stations, and the National Restaurant Association.

Excellent facilities for the conference are provided on the Cornell campus. They include headquarters at the Statler Inn, a small replica of the Statler Hotel in Washington, which is a part of the hotel management training service of the University. Announcement will be made later as to accommodation details. Many new and outstanding conference features are being prepared by the program committee.

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